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REVISED STANDARD FREQUENCY BROADCASTS

The Bureau's standard frequency station, WWV, was destroyed by fire November 6. A temporary transmitter has been established in another building and has begun a reduced service. It broadcasts the frequency 5 megacycles (5,000 kilocycles) per second, every day (except Sunday) from 10 a. m. to midnight. This is continuous wave only, with telegraphic code announcements of the call letters WWV every 20 minutes. The accuracy of the frequency is the same as in the past, namely, better than a part in 10 million.

The broadcast is from a 1-kilowatt transmitter. Generally speaking, it is most useful for moderate distances in the daytime and long distances at night. More precisely, for reception in locations reasonably free from interference, it is receivable at all distances up to 1,000 miles from Washington in the middle of the day. The distance range increases after about 4 p. m. (EST) until at night the broadcast is receivable throughout the United States; sometimes at night it may be difficult to receive it at distances between 50 and 500 miles, while it is easy to receive it beyond 500 miles. In the spring the daytime distance range will decrease, dropping to about 500 miles in the summer.

This restricted service will continue for some months. As rapidly as possible a new station will be established to provide more fully than in the past, standard frequencies receivable at all times throughout the country. These will include standard radio frequencies, standard seconds pulses, and the standard of musical pitch, 440 cycles per second, which will unfortunately not be available during the period in which the temporary transmitter is used.

[1] Published with approval of the Director of the Budget.

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ALTERNATING-CURRENT GROUNDS ON WATER PIPES

The technical subcommittee of the American Research Committee on Grounding has been investigating complaints covering damage to water systems in houses and pollution of water flowing in the pipes. The Bureau is represented in this work by Morton G. Lloyd, Chief of the Safety Codes Section.

The subcommittee has issued a summary report covering 21 complaints in 7 communities, showing that in none of these cases was there evidence to indicate that the flow of alternating current over water pipes or mains by itself has caused damage to the piping or to the water flowing in the pipes. On the other hand, the investigations revealed differences in the chemical composition of the water supplied to a given user; differences in impurities of the metal of which the pipes are made; galvanic action resulting from the indiscriminate use of many different metals, and variations in their composition; differences in the temperature of the hot water supply, and in the rate and amount of water drawn from the mains; and many other factors.

It has not been possible to develop thoroughly all of the complex variables present in the different situations investigated, and definite conclusions are rendered more difficult because of the inability of the subcommittee to obtain more cases for investigation. It is, therefore, not possible at this time to state that damage from alternating current flowing over water pipes could not occur.

For the future, the Grounding Committee expects to continue its investigation of all complaints of water contamination where grounding of electric circuits is involved, to determine, if possible, whether there is any relation in normal practice between superimposed alternating currents and effects on water pipes and the water itself. The committee also proposes to establish simple test set-ups where accelerated reactions might be obtained if such a relation does exist. These set-ups would be of such a nature as not to require continuous observation, but would be placed in water plants or laboratories where occasional checks could be made under the supervision of skilled personnel. However, the necessity for prompt investigation of all complaints would still exist, so as to gain field experience and to correlate the various factors involved.

BONDING JOINTS IN PIPE LINES FOR CATHODIC PROTECTION

During the past few years the use of electrical or cathodic protection to prevent the corrosion of pipe lines has increased rapidly. On lines joined by mechanical couplings, one of the chief items of cost in installing the protective system is that of bonding across the couplings. These bonds are not always successful; some of them become detached from the pipe.

An investigation was made by Scott Ewing, research associate of the American Gas Association, of the methods that might be used to attach copper bond wires to steel pipes. This involved reviewing the experience of railroads in bonding rails; investigating the methods of soldering, brazing, and welding; and obtaining information from pipe-line engineers on their bonding experience.

Although soldered joints have less strength than those made by any other method, and they have been unsuccessful on electric railroads, they have been satisfactory on many cathodic protection systems. The greatest difficulty has been experienced with brazed joints, although copper strips, welded to the pipe, have proved successful. While any of the above methods of joining will probably be satisfactory if the work is properly done, the cost of installing the bonds is likely to be high with some methods, and at times it is extremely difficult to make a good joint in the field.

It is believed that a cheaper and more dependable bond will be obtained by the use of steel terminal copper bonds than by any other means. Tests are now being made which it is hoped will lead to the development of such a terminal. These bonds can be manufactured by methods similar to those used for rail bonds; and if the demand for them is sufficient, their moderate price should make the total cost of the installation lower than that of any other type of pipe-line bond.

EFFECT OF LOW TEMPERATURES ON THE PROPERTIES OF AIRCRAFT METALS

Because of the lack of essential information on the mechanical properties of aircraft metals at low temperatures, the subject was investigated by Samuel J. Rosenberg, of the Bureau's Metallurgy Division, and the findings will be published in the December Journal of Research (RP1347).

Practically all metallic alloys used in aircraft construction were investigated. These were divided into three classes: (1) Ferritic steels, (2) austenitic stainless steels and nickel alloys, and (3) light metal alloys (aluminum- and magnesium-base). The effect of temperatures down to −78° C (−108° F) upon the tensile properties, hardness, and impact resistance of these materials was determined.

It was found that low temperature had no bad effect on any of these properties, with the exception of the impact resistance of the ferritic steels. In the case of these steels, a decrease in impact resistance occurred as the test temperature was lowered.

A PHOTOMETRIC PROCEDURE USING BARRIER-LAYER PHOTOCELLS

The introduction in recent years of light sources of various colors, such as fluorescent lamps, has brought up the problem of measuring their candlepower. In the Journal of Research for December (RP1348), Louis E. Barbrow describes a procedure in which photoelectric cells of the barrier-layer type are used for measuring the candlepower of such light sources. These photoelectric cells have been corrected so as to have a spectral response simulating that of the average eye. Any remaining difference of spectral response between the cell and the average eye is compensated by the use of filters. Results obtained in the photometry of vacuum and gas-filled tungsten-filament lamps and "white" and "daylight" fluorescent lamps, and in the determination of the transmission factors of colored filters are given.

USE OF AZEOTROPIC DISTILLATION IN SEPARATING PETROLEUM HYDROCARBONS

At the annual meeting of the American Petroleum Institute, in Chicago, a paper was presented on November 13 before the Division of Refining entitled "The use of azeotropic distillation in separating hydrocarbons from petroleum", by Frederick D. Rossini, Beveridge J. Mair, and Augustus R. Glasgow, Jr., of the American Petroleum Institute Research Project 6 at the Bureau. The paper contains a discussion of the principles involved in azeotropic distillation, the substances that form azeotropic mixtures with hydrocarbons and their selection, and the separation of hydrocarbons by azeotropic distillation, including aromatics from naphthenes and paraffins, naphthenes from paraffins, aromatics of different degree of "aromaticity", and one-ring naphthenes from poly-ring naphthenes. The benefits accruing as a result of systematic and efficient distillation at a reduced pressure, prior to the azeotropic distillation, are pointed out. A general procedure is outlined for separating a given fraction of petroleum (gasoline or kerosene) by distillation alone, in its several variations of distillation at normal pressure, distillation at reduced pressure, and distillation with an azeotrope-forming substance. The hydrocarbons which can be separated from petroleum in a substantially "pure" state by distillation alone are listed, and several practical applications of azeotropic distillation are mentioned.

STANDARD ELECTRODE POTENTIAL OF SODIUM

The reaction of the alkali metals with water disturbs the equilibrium conditions necessary for direct measurements of their electrode potentials. An indirect method which overcomes this difficulty depends on the possibility of measuring (a) the potential of a dilute amalgam of the alkali metal with respect to an aqueous solution of its ions and a reference electrode, and (b) the difference in potential between the same amalgam and the pure metal when both are immersed in a nonaqueous conducting solution containing ions of the alkali metal. By this method the standard electrode potentials of the alkali metals have all been measured. However, these measurements have usually involved the introduction of one or more of the uncertainties caused by the use of liquid junctions, solutions for which the activities can only be approximated, and unreliable reference electrodes. RP1350 in the December Journal of Research gives the results of a redetermination by Edgar Reynolds Smith and John Keenan Taylor of the standard electrode potential of sodium, in which these sources of possible error were eliminated. The two cells measured may be represented by

$$\mathrm{Na(s)\,;\ NaI(in\ dimethylamine)\,;\ Na(amalgam)}$$

and

$$\mathrm{Na(amalgam)\,;\ NaCl}(m)\mathrm{,\ AgCl(s)\,;\ Ag(s)}.$$

The standard electrode potential $\mathrm{Na(s)\,;\ Na^+}$ was obtained over the temperature range of 5° to 40° C. The final results may be expressed by the equation

$E° = 2.71324 + 0.0007532\ (t - 25) + 0.000000688\ (t - 25)^2$, in which $E°$ is in international volts and t is in degrees centigrade.

PREPARATION OF BENZOIC ACID OF HIGH PURITY

In the Journal of Research for December, Frank W. Schwab and Edward Wichers describe (RP1351) the preparation of benzoic acid of extremely high purity.

For many years benzoic acid has been used as a standard substance in acidimetry and for the calibration of bomb calorimeters. Certified samples of the material have been issued by the Bureau since 1911. Recently, it became necessary to prepare some of the material of the highest practicable purity, primarily for a determination of the heat of combustion of the pure substance.

A number of methods for preparing pure benzoic acid were compared, both with respect to the degree of purity and the ease with which it could be attained. Simultaneously, a study was made of means for determining the purity of the substance. The methods adopted for determining purity were based on very precise determinations of the freezing range of the acid and on measurements of the specific heat of the solid substance at temperatures closely approaching its melting point.

The methods of preparation which were studied were: Purification of a commercial material, which was about 99.98 percent pure, by fractional distillation in vacuum; fractional freezing, and crystallization from solvents; and preparation from other substances by selected reactions. A purity of 99.999 mole percent was attained by each of three methods: Crystallization from benzene; fractional freezing; and hydrolysis of benzoyl chloride, purified by fractional distillation. Crystallization from water gave material 99.996 percent pure in the same number of steps that yielded the purer material by crystallization from benzene. The ready availability of pure water partly offsets the advantage of the more rapid purification from benzene. Hydrolysis of benzoyl chloride is rapid and easy, but involves painstaking preliminary purification of the parent substance. Fractional freezing is a relatively simple and rapid method. The freezing point of benzoic acid is tentatively given as 122.36°±0.01° C.

SOLUTION OF OSMIRIDIUM AND OTHER REFRACTORY MATERIALS IN ACIDS AT HIGH TEMPERATURES

Osmiridium, a natural alloy of metals of the platinum group, is the principal source of the rare but important metal iridium, which at present market values commands about four times the price of platinum. This mineral is relatively abundant in the Alaskan platinum deposits which constitute the only important platinum-metal resource of the United States. Determination of its iridium content has been one of the analyst's most difficult problems, in part because the native alloy is so hard to get into solution.

In usual practice, osmiridium is brought into solution for analysis by a laborious treatment with alkaline oxidizing fluxes. The other alloys found in the native platinum minerals can be dissolved rather readily by means of the mixture of hydrochloric and nitric acids known as aqua regia. At temperatures up to 100°C, above which it cannot be used in open vessels, aqua regia is entirely without effect on the osmiridium. At temperatures approaching 200° the acid mixture begins to attack the alloy, and at 250° to 300° C the attack is rapid enough to afford a practicable means of dissolving the material preparatory to analysis. Iridium, by itself, is dissolved somewhat more slowly than osmiridium, and the metals osmium, ruthenium, and rhodium more rapidly. The treatment as developed by E. Wichers and W. G. Schlecht, of the Bureau's Chemistry Division, is conducted in a sealed glass tube enclosed in a steel shell which is charged with compressed air to offset the high pressures (as high as 3,000 lb/in^2) developed by the acid mixture.

The rate of attack varies greatly with the composition of the acid mixture as well as with the temperature. At present a mixture of 20 volumes of concentrated hydrochloric acid and 1 volume of fuming nitric acid, at a temperature of about 275° C, is recommended; but work now in progress may disclose better operating conditions. One or two days may be required for complete solution, depending upon the size of the grains, but the operation requires no attention during that time. About 20 milliliters of the acid mixture is needed to dissolve 1 gram of osmiridium. When the sample is dissolved, the tube is cooled with dry ice before opening it, to prevent loss of any volatile substances, such as osmium tetroxide.

Certain other materials which have been troublesome to get into solution for analysis respond to the same kind of treatment. Examples are sintered aluminum and beryllium oxides, many silicate rocks, and complex rare-metal alloys containing chromium, molybdenum, tungsten, etc. For some of these substances hydrochloric acid is used rather than aqua regia. Outstanding advantages of the method are that only volatile reagents are used and that contamination of the sample with impurities from reagents is minimized.

STANDARD COLOR TEST FOR PORCELAIN ENAMELS

For several years the Bureau has cooperated with the Porcelain Enamel Institute in developing standard tests for porcelain enamels. One current project is a standard test for evaluating color differences between nearly identical specimens. For this work a special subcommittee of the Institute was formed, members of which prepared 15 sets of 13 specimens each. Every set consisted of a central standard and 12 other specimens having slight, systematic differences from the standard in their hue saturation and lightness. The colors of the central standards were widely varied within the possible range.

Visual estimates of the directions and magnitudes of the differences between the central standards and the similarly colored specimens in the respective sets have been made at the Bureau and at several cooperating laboratories. Additional estimates are planned. Several different means of determining these differences by computation from data obtained on various instruments are also being tried. It is planned to modify the formulas or, if necessary, one or another of the instruments, until reasonably good agreement between such determinations and the averages of visual estimates can be obtained. If this can be done successfully, the instrumental method will be recommended as standard, and can be used both as a control method for manufacturers and a test method for purchase specifications.

SPECIFIC REFRACTION AND DISPERSION OF GLASSES

Recently John C. Young and Alfred N. Finn, Chief of the Bureau's Glass Section, have made many new glasses of unusual composition, containing, in varying amounts, such elements as rubidium, cesium, gallium, yttrium, indium, lanthanum, cerium, praseodymium, neodymium, samarium, gadolinium, holmium, erbium, columbium, tantalum, etc. Refractive index and density data on these glasses, as well as similar data from the literature on the ordinary constituents of glass, have been examined statistically to determine the applicability to glass of several of the better known specific refraction ratios. It was found that of these ratios only the Gladstone-Dale ratio possesses each of the following features: For any specified wavelength of light it is independent of the thermal history of a given glass, and it varies linearly with composition. It is also useful, in combination with "specific dispersion", for computing the μ-value, or "dispersive index", of a glass.

In RP1352, which will be published in the December number of the Journal of Research, definite numerical factors are given for 32 glass-making oxides, from which one can compute the specific refraction as well as the dispersive index, or μ-value, of a glass composed entirely of any or all of these oxides. These factors are shown to be related to the periodicity of the elements. The ability to predict the dispersive index (μ) of a glass should be of considerable interest to optical glass manufacturers, because it will assist them in designing better glasses for telescopes, binoculars, cameras, etc.

PORE SYSTEM IN BRICKS AND ITS RELATION TO FROST ACTION

Certain properties associated with the porous structure of bricks have an important bearing on their durability when exposed to the weather. These properties have received scant attention heretofore, and an investigation was made by Ray T. Stull and Paul V. Johnson to obtain data on these properties and on their relation to the failure of bricks as a result of freezing and thawing. Seven series of bricks, the products of five different manufacturers, were selected to represent ranges in hardness, methods of manufacture, and temperature at which they had been burned. The properties determined were: Percentage of porosity; variation in porosity within a brick; permeability to air and water; the flow of air through two members in series; effect of time, under continuous flow, on the water permeability; the mean capillary radius and the number of capillaries in an ideal structure which would have the same permeability as that determined experimentally for the brick; saturation coefficient by 48 hours' im-

mersion; increase in saturation coefficient with repeated freezing and thawing, and the resistance of bricks to failure by repeated freezing and thawing.

The variation in porosity of a brick is partly responsible for its lack of uniform structure and is, therefore, a contributing factor affecting its life when subjected to repeated freezing and thawing.

No definite correlation was found as to location of lowest, medium, and highest porosities of individuals among the bricks tested. The differences between maximum and minimum percentage porosities of the different sections of the individual bricks ranged from 2.8 to 10.4, a spread of 11.6 to 48.4 percent.

When the air-permeability values, f_1 and f_2 of two members composing a unit, and their relative thicknesses, T_1 and T_2, are known, the air conductance, F, of the unit can be determined by application of the equation.

$$F=\frac{f_1 f_2}{f_1 T_2+f_2 T_1}.$$

The differences between the calculated and experimental F values determined were so small as to be negligible.

The mean effective capillary radius, permeability, and number of cycles of freezing and thawing to cause failure of the bricks increase, and the pore volume, number of capillaries, and saturation coefficient decrease with increase in burning temperature. The decrease in pore volume and number of pores indicates that some pores have become filled or sealed and, therefore, inactive so far as permeability and absorption are concerned. The increase in mean effective capillary radius and decrease in number of capillaries indicate that the pores rendered inactive were chiefly the smaller ones originally occurring as microcavities formed by the microparticles.

The air permeabilities were constant with respect to time of flow, whereas the water permeabilities varied, increasing with time for those bricks having mean capillary radii less than 2 microns and decreasing for those with radii greater than 2 microns.

The saturation coefficient increases with increase in the number of freezing and thawing cycles. The relation between these two variables appears to be hyperbolic in character, and may be expressed empirically by the equation

$$S=a-\frac{K}{b+C},$$

where S is saturation coefficient, C, the cycles of freezing and thawing and a, b, and K are constants for a definite brick but different for different bricks. The constant a represents (theoretically) the upper limiting value of the saturation coefficient under the assumption that the brick would stand an infinite number of freezing and thawing cycles.

Bricks considerably laminated may attain saturation coefficients greater than unity by repeated freezing and thawing, thus containing larger volumes of water than their initial pore volumes.

The general trend of the data indicates that the number of cycles of freezing and thawing to cause failure of the brick increases when the permeability and effective capillary radius increase, and when the porosity, number of capillaries, and saturation coefficient decrease.

The Journal of Research for December will contain the complete account of this investigation, which will be published as RP1349.

WEATHERING TESTS OF ASPHALT SHINGLES

Recent experimental work on the absorption of water by asphalt shingles has led to the development of a new blistering test. In the usual procedure, the shingle is immersed in water for a short time and is then subjected to a temperature of 221°F for 1 hour. Experimental data showed this test to be wrong in principle, as it did not take into consideration the "breathing action" of the shingles. A new test was therefore devised which takes this "breathing" into account. In this test the specimen is subjected to a certain set of conditions which is repeated daily for about a week. The specimen is never exposed to a temperature higher than 194°F.

STRENGTH AND ELONGATION OF SILK YARNS AS AFFECTED BY HUMIDITY

The strength of silk hosiery yarns is not significantly affected by changes in relative humidity of the surrounding air between 33 and 55 percent, but the strength is less when the relative humidity is above these limits. Maximum strength at these humidities is obtained with yarns having a twist of approximately 15 turns per inch, according to E. Max Schenke, Director of Research, and Howard E. Shearer, Research Associate, of the National Association of Hosiery Manufacturers, who have been studying this matter at the Bureau. A report of the results of their studies will appear as RP1353 in the December issue of the Journal of Research.

The yarns studied varied in number of threads from 2 to 9, and in number of turns of twist per inch from 5 to 36. They were tested for breaking strength and breaking elongation at 70°F after various periods of exposure in relative humidities from 33 to 86 percent. The elongations of the yarns increased with an increase in relative humidity of the air. The elongation, on the average, increased 1 percent with increase in relative humidity from 33 to 43 percent, and 1.9 percent with an increase in relative humidity from 76 to 86 percent. The average strength of all yarns was 3.41 grams per denier when tested under standard conditions.

NEW AND REVISED PUBLICATIONS ISSUED DURING NOVEMBER 1940

Journal of Research [2]

Journal of Research of the National Bureau of Standards, volume 25, number 4, October 1940 (RP1333 to RP1340, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Research Papers [2]

[Reprint from the September 1940 Journal of Research]

RP1326. Pectic substance of cotton fibers in relation to growth. Roy L. Whistler, Albert R. Martin, and Carl M. Conrad. Price 5 cents.

Commercial Standards [2]

CS80–41. Electric direction signal systems other than semaphore type for commercial and other vehicles subject to special motor-vehicle laws (after market.) Price 5 cents.

CS85–41. Electric license-plate lamps for vehicles (after market). Price 5 cents.

CS86–41. Electric stop lamps for vehicles (after market). Price 5 cents.

CS88–41. Liquid-burning flares. Price 5 cents.

Technical News Bulletin [2]

Technical News Bulletin 283, November 1940. Price 5 cents. Annual subscription, 50 cents.

[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $3.50 per year (to addresses in the United States and its possessions, and to countries extending the franking privilege); other countries, 70 cents and $4.50, respectively.

MIMEOGRAPHED MATERIAL

Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC608. Detergents and related subjects. (Supersedes LC403.)

LC610. Electric batteries and standard cells: Publications by the staff of the National Bureau of Standards and references to other sources of information. (Supersedes LC553.)

LC612. List of Simplified Practice Recommendations. (Supersedes LC594.)

LC616. Etching of designs and lettering on metals.

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS [3]

API pipe-coating tests—final report. Kirk H. Logan. Preprint, paper before twenty-first annual meeting, Am. Petroleum Institute (250 Park Ave., New York, N. Y.) (Nov. 14, 1940).

Introductory dialogue for a symposium on spectrophotometry in the pulp and paper industries. Deane B. Judd and L. C. Lewis. Paper Trade J. (10 E. 39th St., New York, N. Y.) 111, TS133 (Sept. 5, 1940).

Survey of spectrophotometers. Kasson S. Gibson. Paper Trade J. 111, TS135 (Sept. 5, 1940).

Systematic color designations for paper. Deane B. Judd. Paper Trade J. 111, TS201 (Oct. 17, 1940).

Sorption of water by plastics. G. M. Kline, A. R. Martin, and W. A. Crouse. Modern Plastics (122 E. 42nd St., New York, N. Y.) 18, 119 (Oct. 1940).

The transformation of austenite. T. G. Digges. Metal Progress (7301 Euclid Ave., Cleveland, Ohio) 38, 419 (Oct. 1940).

Oxides extracted in Merriman's test of portland cement. E. P. Flint and P. H. Bates. Rock Products (330 So. Wells St., Chicago, Ill.) 49, No. 10, 46 (Oct. 1940).

[3] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

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